

CLAIMS

What is claimed is:

1. A nozzle apparatus for vacuum removal of debris, comprising:
  - a tubular base member capable of being attached to a conduit;
  - 5 an extensible member slidably coupled to said base member;
  - said extensible member configured for longitudinal extension and retraction;
  - said extensible member having a nozzle tip; and
  - means for extending or retracting said extensible member.
- 10 2. An apparatus as recited in claim 1, wherein said means for extending or retracting said extensible member comprises a controllable actuator.
- 15 3. An apparatus as recited in claim 1, further comprising:
  - a coupling member;
  - said coupling member configured for coupling said tubular base member to a conduit.
4. An apparatus as recited in claim 3, wherein said base member is pivotally coupled to said coupling member.
- 20 5. An apparatus as recited in claim 4, further comprising means for pivoting said base member in relation to said coupling member.

6. An apparatus as recited in claim 5, wherein said means for pivoting said base member comprises a controllable actuator having a first end coupled to said base member and a second end coupled to said coupling member.

5 7. An apparatus as recited in claim 3, wherein said coupling member is configured to dampen and reduce the force of impact of the apparatus with a surface during use.

10 8. An apparatus as recited in claim 3, wherein said coupling member comprises a universal joint configured for coupling said base member to a conduit.

15 9. An apparatus as recited in claim 8, wherein said universal joint comprises: an upper tray configured for coupling to said conduit; and a lower tray coupled to said nozzle assembly; said lower tray coupled to said upper tray with a plurality of resilient members; wherein the joint between said base and a conduit is compliant.

20 10. An apparatus as recited in claim 8, wherein said universal joint is

configured to rotate axially.

11. An apparatus as recited in claim 1, further comprising a nozzle tip coupled to said extensible member.

12. An apparatus as recited in claim 11, wherein said nozzle tip is pivotally coupled to said extensible member.

13. An apparatus as recited in claim 11, wherein said nozzle tip further 5 comprises:

a flexible tube coupled to said extensible member and having an open end; and means for changing the direction of said open end of said flexible tube.

14. An apparatus as recited in claim 13, wherein said means for changing the 10 direction of the end of said nozzle comprises:

a nozzle bracket pivotally mounted to said extensible member; said bracket coupled to said flexible tube and mounted to a distal end of said extensible member; said flexible tube having a nozzle mouth; and at least one pair of long stroke controllable actuators mounted to said nozzle bracket;

wherein differential actuation of said actuators changes the direction of nozzle bracket and said end of said flexible tube.

20 15. An apparatus as recited in claim 14, wherein said nozzle mouth is pivotally coupled to said nozzle bracket.

16. A nozzle apparatus for vacuum removal of debris, comprising:  
a tubular base member capable of being attached to a conduit;  
an extensible member slidably coupled to said base member;  
said extensible member configured for longitudinal extension and retraction;  
5 said extensible member having a nozzle tip; and  
a controllable actuator configured for extending or retracting said extensible  
member.

17. An apparatus as recited in claim 16, further comprising:  
10 a coupling member;  
said coupling member configured for coupling said tubular base member to a  
conduit.

18. An apparatus as recited in claim 17, wherein said base member is  
15 pivotally coupled to said coupling member.

19. An apparatus as recited in claim 18, further comprising means for pivoting  
said base member in relation to said coupling member.

20. An apparatus as recited in claim 19, wherein said means for pivoting said  
base member comprises a controllable actuator having a first end coupled to said base  
member and a second end coupled to said coupling member.

21. An apparatus as recited in claim 17, wherein said coupling member is configured to dampen and reduce the force of impact of the apparatus with a surface during use.

5 22. An apparatus as recited in claim 17, wherein said coupling member comprises a universal joint configured for coupling said base member to a conduit.

10 23. An apparatus as recited in claim 22, wherein said universal joint comprises:

15 an upper tray configured for coupling to said conduit; and  
a lower tray coupled to said nozzle assembly;  
said lower tray coupled to said upper tray with a plurality of resilient members;  
wherein the joint between said base and a conduit is compliant.

20 24. An apparatus as recited in claim 22, wherein said universal joint is configured to rotate axially.

25. An apparatus as recited in claim 16, further comprising a nozzle tip coupled to said extensible member.

26. An apparatus as recited in claim 25, wherein said nozzle tip is pivotally coupled to said extensible member.

27. An apparatus as recited in claim 25, wherein said nozzle tip further comprises:

a flexible tube coupled to said extensible member and having an open end; and means for changing the direction of said open end of said flexible tube.

5

28. An apparatus as recited in claim 27, wherein said means for changing the direction of the end of said nozzle comprises:

a nozzle bracket pivotally mounted to said extensible member;

said bracket coupled to said flexible tube and mounted to a distal end of said

10 extensible member;

said flexible tube having a nozzle mouth; and

15 at least one pair of long stroke controllable actuators mounted to said nozzle bracket;

wherein differential actuation of said actuators changes the direction of nozzle

bracket and said end of said flexible tube.

29. An apparatus as recited in claim 28, wherein said nozzle mouth is pivotally coupled to said nozzle bracket.

20 30. A particulate matter moving apparatus, comprising:

a dexterous extensible nozzle assembly configured to be pivotally coupled to a conduit; and

means for manipulating the position of the nozzle assembly;  
wherein the elevation and location of said nozzle assembly can be precisely  
adjusted.

5       31. An apparatus as recited in claim 30, wherein said dexterous nozzle  
assembly further comprises a universal joint capable of coupling said nozzle assembly  
to a conduit.

10      32. An apparatus as recited in claim 31, wherein said universal joint  
comprises:  
an upper tray configured for mounting to a conduit;  
said upper tray having an annular channel;  
a lower tray mounted to said nozzle assembly;  
said lower tray coupled to said upper tray; and  
15     a plurality of flexible bearings evenly disposed within said annular channel of  
said upper tray;  
wherein said nozzle assembly can rotate axially.

20      33. An apparatus as recited in claim 30, wherein said extensible nozzle  
assembly comprises:  
a cylindrical base;  
a fly slidably coupled to said base; and

a nozzle tip coupled to said fly.

34. An apparatus as recited in claim 33, wherein said nozzle tip further comprises:

5 a flexible tube coupled to said fly and having an open end; and  
means for changing the direction of said open end of said flexible tube.

35. An apparatus as recited in claim 33, wherein said nozzle assembly further comprises a bracket pivotally connected to said fly and said nozzle tip.

10 36. An apparatus as recited in claim 33, wherein said means for manipulating the position of the nozzle assembly comprises:

means for pivotally rotating said nozzle assembly with respect to said conduit;  
means for extending and retracting said fly longitudinally from said base; and  
means for changing the direction of said nozzle tip.

15 37. An apparatus as recited in claim 36, wherein said means for pivoting said nozzle assembly comprises a controllable actuator and flange.

20 38. An apparatus as recited in claim 36, wherein said means for extending and retracting said fly longitudinally from said base comprises:

at least one pair of long stroke cylinders having first and second ends;

10 said first ends mounted to said base and said second ends mounted to said fly.

39. An apparatus as recited in claim 36, wherein said means for changing the  
5 direction of the nozzle tip comprises:

a nozzle bracket pivotally mounted to said fly;

said bracket coupled to a flexible tube mounted to a distal end of said fly;

said flexible tube having a nozzle mouth; and

at least one pair of long stroke cylinders having first and second ends;

15 said first ends mounted to said base and said second ends mounted to said  
nozzle bracket.

40. An apparatus as recited in claim 33, wherein said means for changing the  
direction of the nozzle tip comprises:

a nozzle bracket pivotally mounted to said fly;

said bracket coupled to a flexible tube mounted to a distal end of said fly;

said flexible tube having a nozzle mouth; and

at least one pair of long stroke cylinders having first and second ends;

20 said first ends mounted to a universal joint and said second ends mounted to  
said nozzle bracket.

41. An apparatus as recited in claim 30, wherein said means for manipulating  
the position of the nozzle assembly comprises a controllable actuator.

42. A particulate matter moving apparatus, comprising:  
a dexterous extensible nozzle assembly configured to be pivotally coupled to a  
conduit; and  
a controllable actuator configured for manipulating the position of the nozzle  
5 assembly;  
wherein the elevation and location of said nozzle assembly can be precisely  
adjusted.

43. An apparatus as recited in claim 42, wherein said dexterous nozzle  
10 assembly further comprises a universal joint capable of coupling said nozzle assembly  
to a conduit.

44. An apparatus as recited in claim 43, wherein said universal joint  
comprises:  
15 an upper tray configured for mounting to a conduit;  
said upper tray having an annular channel;  
a lower tray mounted to said nozzle assembly;  
said lower tray coupled to said upper tray; and  
a plurality of flexible bearings evenly disposed within said annular channel of  
20 said upper tray;  
wherein said nozzle assembly can rotate axially.

45. An apparatus as recited in claim 44, wherein said extensible nozzle assembly further comprises:

means for causing the axial rotation of said nozzle assembly.

5 46. An apparatus as recited in claim 45, wherein said means for causing axial rotation of said nozzle assembly comprises:

a set of teeth extending radially from said upper tray; and

a motor with a sprocket configured to engage said teeth;

wherein actuation of the motor caused the axial rotation of said nozzle assembly.

10 47. An apparatus as recited in claim 42, wherein said extensible nozzle assembly comprises:

a cylindrical base;

a fly slidably coupled to said base;

a nozzle tip coupled to said fly; and

means for manipulating the position of the nozzle assembly.

15 48. An apparatus as recited in claim 47, wherein said nozzle tip further comprises:

20 a flexible tube coupled to said fly and having an open end; and

means for changing the direction of said open end of said flexible tube.

49. An apparatus as recited in claim 47, wherein said nozzle assembly further comprises a bracket pivotally connected to said fly and said nozzle tip.

50. An apparatus as recited in claim 47, wherein said means for manipulating the position of the nozzle assembly comprises:

means for pivotally rotating said nozzle assembly with respect to said conduit;  
means for extending and retracting said fly longitudinally from said base; and  
means for changing the direction of said nozzle tip.

51. An apparatus as recited in claim 50, wherein said means for manipulating the position of the nozzle assembly further comprises:

means for causing the axial rotation of said nozzle assembly.

52. An apparatus as recited in claim 50, wherein said means for pivoting said nozzle assembly comprises a controllable actuator and flange.

20 53. An apparatus as recited in claim 50, wherein said means for extending and retracting said fly longitudinally from said base comprises:

at least one pair of long stroke cylinders having first and second ends;  
said first ends mounted to said base and said second ends mounted to said fly.

25

54. An apparatus as recited in claim 48, wherein said means for changing the direction of the nozzle tip comprises:

a nozzle bracket pivotally mounted to said fly;

said bracket coupled to a flexible tube mounted to a distal end of said fly;

5 said flexible tube having a nozzle mouth; and

at least one pair of long stroke cylinders having first and second ends;

said first ends mounted to said base and said second ends mounted to said nozzle bracket.

10 55. An apparatus as recited in claim 50, wherein said means for changing the direction of the nozzle tip comprises:

a nozzle bracket pivotally mounted to said fly;

said bracket coupled to a flexible tube mounted to a distal end of said fly;

15 said flexible tube having a nozzle mouth; and

at least one pair of long stroke cylinders having first and second ends;

said first ends mounted to a universal joint and said second ends mounted to said nozzle bracket.

20 56. A nozzle assembly, comprising:

an outer cylinder;

said outer cylinder having a universal joint capable of coupling said outer cylinder with a conduit;

wherein said universal joint is configured to dampen and reduce shear forces; an inner cylinder disposed within the outer cylinder on a plurality of support rails; means for extending and retracting said inner cylinder with respect to said outer cylinder; and

5 a dexterous nozzle tip coupled to said inner cylinder.

57. A nozzle assembly as recited in claim 56, wherein said universal joint further comprises:

an upper tray configured for mounting to a conduit; and  
a lower tray mounted to said upper tray with a plurality of spring tensioned fasteners disposed radially around the periphery of said upper tray and said lower tray; said lower tray pivotally coupled to said outer cylinder.

58. A nozzle assembly as recited in claim 56, wherein said means for extending and retracting said inner cylinder from said outer cylinder comprises:

at least one pair of long stroke cylinders having first and second ends; said first ends mounted to said outer cylinder and said second ends mounted to said inner cylinder.

20 59. A nozzle assembly as recited in claim 56, wherein said dexterous nozzle tip comprises:

a nozzle bracket pivotally mounted to said fly;

10  
said bracket coupled to a flexible tube mounted to a distal end of said inner cylinder;

15  
said flexible tube having a nozzle mouth; and

20  
at least one pair of long stroke cylinders mounted to said nozzle bracket;

5  
wherein differential actuation of said long stroke cylinders pivots said nozzle bracket.

60. A nozzle assembly as recited in claim 56, wherein said means for

extending and retracting said inner cylinder with respect to said outer cylinder

10  
comprises a controllable actuator.

61. A nozzle assembly, comprising:

15  
an outer cylinder;

20  
said outer cylinder having a universal joint capable of coupling said outer cylinder

with a conduit;

wherein said universal joint is configured to dampen and reduce shear forces;

an inner cylinder disposed within the outer cylinder on a plurality of support rails;

25  
a controllable actuator configured for extending and retracting said inner cylinder

with respect to said outer cylinder; and

30  
a dexterous nozzle tip coupled to said inner cylinder.

62. A nozzle assembly as recited in claim 61, wherein said universal joint further comprises:

an upper tray configured for mounting to a conduit; and

a lower tray mounted to said upper tray with a plurality of spring tensioned

5 fasteners disposed radially around the periphery of said upper tray and said lower tray; said lower tray pivotally coupled to said outer cylinder.

63. A nozzle assembly as recited in claim 62, wherein said universal joint further comprises:

10 a plurality of flexible bearings evenly disposed within a annular channel of said upper tray;

wherein said nozzle assembly can rotate axially.

15 64. An apparatus as recited in claim 63, wherein said nozzle assembly further comprises:

means for causing the axial rotation of said nozzle assembly.

65. An apparatus as recited in claim 64, wherein said means for causing axial rotation of said nozzle assembly comprises:

20 a set of teeth extending radially from said upper tray; and

a motor with a sprocket configured to engage said teeth;

wherein actuation of the motor caused the axial rotation of said nozzle assembly.

66. A nozzle assembly as recited in claim 61, wherein said controllable actuator for extending and retracting said inner cylinder from said outer cylinder comprises:

at least one pair of long stroke cylinders having first and second ends;

5 said first ends mounted to said outer cylinder and said second ends mounted to said inner cylinder.

67. A nozzle assembly as recited in claim 61, wherein said dexterous nozzle

10 tip comprises:

a nozzle bracket pivotally mounted to said fly;

said bracket coupled to a flexible tube mounted to a distal end of said inner cylinder;

said flexible tube having a nozzle mouth; and

15 at least one pair of long stroke cylinders mounted to said nozzle bracket;

wherein differential actuation of said long stroke cylinders pivots said nozzle bracket.

68. A vacuum nozzle assembly, comprising:

20 a cylindrical base;

a universal joint configured for coupling said cylindrical base to an intake conduit; said universal joint having an upper tray configured for mounting to said intake

conduit;

    said upper tray having an annular channel;

    said upper tray having a plurality of teeth;

    a motor having a gear operably engaging said teeth of said upper tray;

5       a lower tray mounted to said cylindrical base;

    a plurality of flexible bearings evenly disposed within said annular channel of said upper tray;

    a plurality of spring tensioned fasteners disposed radially around the periphery of said upper tray tube and said lower tray;

10       a fly slidably coupled to said cylindrical base;

    said fly disposed within the cylindrical base on a plurality of support rails;

    a nozzle bracket pivotally mounted to said fly;

15       said bracket coupled to a flexible tube mounted to a distal end of said inner cylinder;

    said flexible tube having a nozzle mouth; and

    at least one pair of long stroke cylinders having first and second ends;

    said first ends mounted to said cylindrical base and said second ends mounted to said nozzle bracket;

    said long stroke cylinders configured for actuation by a user.